7. Installation

Window installation involves the fixing of window frame at an earlier construction stage and subsequent installation of the window sashes. This is a highly workmanship dependent process. Only trained and approved contractors registered in BCA Contractor Registry under the regulatory workhead RW01 can carry out installation and retrofitting of windows.

7.1. INSTALLATION OF WINDOW MAIN FRAME

There are three window framing systems commonly used in the local industry. These are cast-in window system, sub-frame system and lug system.

7.1.1. CAST-IN WINDOW SYSTEM

The implementation of cast-in window system requires coordination between the window fabricator and the precaster.

Proper handling and protection are important throughout the precast process, delivery and erection of the precast wall panels. Protection of the frames should remain intact throughout the construction phase to avoid physical damages to the frames, which could be costly to rectify or replace.

Figure 7.1: Casting of window frame in precast wall panel

- a) Window frame must be protected throughout the fabrication and construction process
- b) Setting out of window frame in precast wall panel casting mould
- c) Casting of precast wall panel
- d) Completed cast-in window frame
7.1.2. SUB-FRAME SYSTEM

The sub-frame system comprises a sub-frame which is either cast in or anchored to the wall. The main frame is then installed onto the sub-frame at a much later stage of the construction.

- **Installation of sub-frame**
  Proper alignment and setting out of the sub-frame is crucial in ensuring the ease of operation of the window (Figure 7.2).

Figure 7.2: Positioning of sub-frame

<table>
<thead>
<tr>
<th>a)</th>
<th>b)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Positioning of sub-frame using ride up blocks or aluminium shin plates" /></td>
<td><img src="image2.png" alt="Checking of plumb and alignment of sub-frame" /></td>
</tr>
</tbody>
</table>

After confirming the setting out of the sub-frame, anchor the sub-frame to the wall. Sub-frame should be temporary stiffened with timber packs near the point of anchoring/bolting as shown in Figure 7.3.
Anchor/bolt heads and joints between external wall and sub-frame should be sealed with sealant for effective watertightness as shown in Figure 7.4.

Protective tapes should remain intact throughout the subsequent construction works. The temporary stiffeners should also remain in place prior to installation of the inner frames (Figure 7.5).
After completion of all the wet trades around the window opening, the main frame is then fixed onto the sub-frame. Prior to fixing the main frame, the sub-frame should be checked for any physical damages. Any damaged sub-frame should be repaired or replaced. Setting out of the sub-frame should also be verified before the installation of the main frame.

The sub-frame should be cleaned and clear of dust and debris. Dust and debris accumulated in the sub-frame could affect the alignment and fixing of the main frame. It may also cause blockage to the weep holes, resulting in overflow of incidental water into the interior.
The installation of main frame should be carried out only by trained and approved contractors registered in BCA Contractor Registry under workhead RW 01 as shown in Figure 7.7.

**Figure 7.7: Installation of main frame**

- a) Fitting the main frame onto sub-frame
- b) Fitting of the finishing trim. Millet should be used to knock the finishing trim in place

### 7.1.3. LUG SYSTEM

**Installation of frame on brickwall**

Before installation of the window frame, the following checks should be carried out:

- wall opening should be checked for any physical defects. Any defects should be rectified before installation proceeds;
- wall opening should be cleaned and wetted as shown in Figure 7.8; and
- window frame should be checked for any damages, and should come with the correct number / spacing of galvanised straps (Figure 7.9). Defective frames should be replaced.

**Figure 7.8: Clean and wet the wall surface around the opening**

**Figure 7.9: Check the number, dimensions, and spacing of galvanized straps**

- a) Check numbers of straps
- b) Check spacing of straps
Timber V-shaped wedges are commonly used to temporarily hold the window frame in position within the wall opening as shown in Figure 7.10. The window frame is then checked for plumb, levelness and alignment (Figure 7.11). Tolerances that are stated in Table 7.2 should be followed when installing the window frame.

**Figure 7.10: Use of V-shaped timber wedges for positioning of frame**
After confirming the position of the frame, the galvanised straps are ramsetted to the wall. When ramsetting the straps, the plumb line should be maintained to ensure proper alignment of the frame. The levellness and squareness of the installed frame can be checked by carrying out a diagonal dimensional check as shown in Figure 7.12.

Table 7.2 Tolerances for Installation of Window Frame

<table>
<thead>
<tr>
<th>Items</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal and vertical position on elevation from site datum</td>
<td>± 10mm</td>
</tr>
<tr>
<td>Horizontal position relative to adjoining wall finishes</td>
<td>± 2mm</td>
</tr>
<tr>
<td>Level</td>
<td>± 2mm in any one structural bay</td>
</tr>
<tr>
<td>Plumb</td>
<td>± 2mm in any one storey height</td>
</tr>
<tr>
<td>Plane</td>
<td>± 2mm in any one storey height or structural bay width</td>
</tr>
<tr>
<td>Intersection</td>
<td>± 2mm in alignment in any direction between any two adjoining windows</td>
</tr>
</tbody>
</table>

Source: National Productivity and Quality Specification (NPQS)
Figure 7.12: Fixing of window frame

![Fixing of window frame](image)

- **Installation of frame on precast and cast-in situ RC walls**

  The lug system can also be used on precast and cast-in situ RC walls which are finished with skim coat. In such cases, recesses of 20mm deep (as shown in Figure 7.13) should be provided to accommodate the installation of the straps/brackets. These recesses should be provided during the casting of the RC walls and in accordance with the specified spacing of the straps/brackets.

  Another method for fixing the frame to skim-coated precast or in-situ RC wall is to anchor the frame to the concrete wall. A bottom frame is installed on the bottom edge of the wall opening. Proper alignment and levelness must be verified before sealant is used to seal the gap between the wall and the bottom frame to ensure watertightness at this location.

  The window main frame is then held in place within the wall opening using timber wedges, and checked for alignment, plumb and squareness. Next, the frame is fixed to the wall using anchors of adequate size and length required to support the size and weight of the window system.

Figure 7.13: Recesses formed in RC wall to accommodate the straps/brackets

![Recesses formed in RC wall to accommodate the straps/brackets](image)
**Figure 7.14: Installation of frame using anchors**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Check the levelness of the bottom frame</td>
</tr>
<tr>
<td>b)</td>
<td>Apply sealant along the bottom edge of the wall</td>
</tr>
<tr>
<td>c)</td>
<td>Install the bottom frame and seal the gap between wall and bottom frame</td>
</tr>
<tr>
<td>d)</td>
<td>Check the alignment of the main frame</td>
</tr>
<tr>
<td>e)</td>
<td>Fix the main frame to the wall</td>
</tr>
<tr>
<td>f)</td>
<td>Anchor of adequate length and size should be used</td>
</tr>
</tbody>
</table>
7.1.4. SEALING OF GAP BETWEEN WALL AND WINDOW FRAME

The gaps between the window frame and wall must be properly sealed to prevent water seepage at these locations. Depending on the size of the gap, waterproof grouting or sealant can be used.

- **Application of sealant**

Sealant could be used to seal the gap between wall and window frame if the gap size is between 7-10mm. Before the application of sealant, clean the aluminium window frame with white spirit using a clean rag. The frame and wall surfaces around the gap should be protected with masking tape to prevent the sealant from staining these surfaces and to obtain a neat sealant joint.

Backer rod should be used to achieve better compactness of the applied sealant. To obtain a complete seal, apply sealant by pushing the bead forward into the joint cavity.

The joint should have continuous caulking to ensure that all areas are filled. Remove the excess sealant and tool the joint to achieve a smooth surface.

---

**Figure 7.15: Application of sealant**

<table>
<thead>
<tr>
<th>a) Protection of the frame with masking tape</th>
<th>b) Protection of the wall with masking tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>c) Application of sealant</td>
<td>d) Application of sealant with backer rod</td>
</tr>
</tbody>
</table>

---
• **Grouting**

Gap between 11-25mm could be sealed by grouting. Before commencing the grouting work, it is important to check that the protective tape on the window frame is intact. Any damaged or loose protective tape must be replaced to prevent staining to the frame.

Wall surface to receive the grout should be cleaned with water to remove any dust and loose particles and to minimise water absorption from the grout by the masonry wall (Figure 7.16).

Non-shrink grout should be used to prevent cracks and water seepage around the window. For better performance, the mortar mix ratio should be 1 part of water to 3 parts of concreting sand. Approved waterproofing compound could be added to the mortar mix to enhance the watertightness performance of the grout.

For effective grouting, a suitable grouting gun should be used. Timber strip could be used to provide a firm backing during grouting to enhance compactness of the grout as shown in Figure 7.17.

![Figure 7.16: Cleaning surface to get rid of dust and particles](image)

**Figure 7.16: Cleaning surface to get rid of dust and particles**

**Figure 7.17: Grouting process**

- a) Mortar mixed with waterproofing compound
- b) Use of suitable grouting gun
- c) Use of timber strip as backing
- d) Tooling the grout to give a neat surface

Allow the grouting to cure for 2-3 days, and check for any defect such as cracks and voids. Any defect should be rectified before proceeding to the next stage of work.
7.1.5. WATERPROOFING

It is recommended that a layer of approved waterproofing membrane be applied over the external surface of the joint areas between the wall and window frame before plastering or skim coating of the external walls. This will help to enhance water tightness at these areas (Figure 7.18).

During plastering, a groove line should be made on the external face of the wall around the perimeter of the window (Figure 7.19). Sealant is then applied over these groove lines after the plaster is completely cured. The surface to receive the sealant should be cleaned and free of oil.

For wall with textured coating, the sealant must be applied before the texture coating, as the coating in the groove will affect the adhesion properties of the sealant. Polyurethane sealant should be used where sealant is to be painted over.

Figure 7.20: Application of sealant between window frame and the wall surface
7.2. INSTALLATION OF WINDOW GLAZING

It is recommended that glazing work for inner glass panels be carried out in the factory, where higher work quality can be achieved. Where this is not possible, glazing work must be carried out on site with proper handling and good workmanship. For fixed glass panels, glazing is usually done on site.

This section will discuss the good practices to be adopted when carrying out glazing works on site.

For glazing work in the factory, refer to Chapter 6 on Fabrication.

7.2.1. PREPARATORY WORKS BEFORE GLAZING

The protective tapes should only be removed when glazing works is to be carried out. The following verification works should be carried out prior to glazing work:

<table>
<thead>
<tr>
<th>Verification</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Window Frame</td>
<td></td>
</tr>
<tr>
<td>• Inner frame and associated hardware should be checked for defects. Damaged frames or hardware should be replaced.</td>
<td></td>
</tr>
<tr>
<td>• Inner frame should be cleaned and free from dust and debris.</td>
<td></td>
</tr>
<tr>
<td>• Weep holes in the inner frames should be cleared of blockage to allow discharge of incidental water.</td>
<td></td>
</tr>
</tbody>
</table>
### Verification

<table>
<thead>
<tr>
<th>Glass Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Compliance with physical specifications such as dimensions of panel</td>
</tr>
<tr>
<td>• Labels on the glass panels should be checked against the window schedule.</td>
</tr>
<tr>
<td>• For tempered/laminated glass, check for the associated logo/trademark labels.</td>
</tr>
<tr>
<td>• The orientation of the glass panels should be standardised such that the positioning of these logos/trademarks is consistent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gasket</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Gasket should be checked for any physical damages. Defective gasket should not be used.</td>
</tr>
<tr>
<td>• Gasket should be free from dust and dirt to ensure good grip onto the frame and beadings.</td>
</tr>
<tr>
<td>• Profile of the gaskets should be compatible with that of the beads used to secure the glass panels.</td>
</tr>
</tbody>
</table>
7.2.2. **GLAZING OF GLASS TO INNER FRAME**

There are generally two installation arrangements when glazing the glass panels to the inner frames of casement, top hung or bottom hung windows. Glazing can be carried out either before or after the inner frame is installed onto the main frame. The glazing process is similar for both arrangements. However, extra care should be exercised when carrying out glazing work on inner frame which has already been fixed onto the outer frame, with emphasis placed on safety of the workers and material handling outside the building envelope.

Large glass panels should be handled with suction cups as shown in Figure 7.21. Spacer blocks are normally used to temporarily hold the glass panel in place.

**Figure 7.21: Glazing of glass to inner frame**

a) Inserting glass panel onto the window frame  
b) Use of spacer blocks to hold the glass panel in place

Gasket used should be of a continuous length, and should be carefully spliced at appropriate locations to go around the corners of the glass panel. A suitable tool can be used to press the gasket into the gap between the glass panel and the inner frame to obtain a good fitting to hold the glass panel in place and to prevent water seepage.

**Figure 7.22: Installation of gasket**

a) Estimate the length of the gasket required  
b) Splice the gasket to fit the corners of the glass panel
The glass panel is then secured in position using aluminium beads. The profile of the beads should be verified for compatibility with the gasket used. Millet or the back of rubberized screwdriver can be used to knock the beadings in place. Poorly fitted beading will result in gaps and misalignment of joints.

Figure 7.23: Securing the glass panel with beadings

After the installation of beadings, the gap between the glass panel and the bead should be sealed. Suitable sealant applicator and sealant should be used in accordance with the specifications. The frame and glass should be protected with masking tapes prior to sealant application. A simple tool as shown in Figure 7.24 can be used to give a neat finish. The masking tape should only be removed after the sealant is dry.
7.3. INSTALLATION OF WINDOW INNER FRAME

7.3.1. CASEMENT/ TOP HUNG/ BOTTOM HUNG WINDOWS

The inner frame of casement window is fixed to the main frame using friction stays. The friction stays should be fixed using adequate number of stainless steel screws or rivets of sufficient size, depending on the size and weight of the inner frame. For better watertightness, seal screw or rivet heads with sealant.

The alignment and operation of the window panel should be checked before and after installation.

The installation of top hung or bottom hung window panels are similar to that of the casement window.
### 7.3.2. SLIDING WINDOWS

Sliding windows are installed in 2 stages - installation of main window frame with the sliding tracks at an early construction stage, and installation of the sliding panels at a later stage of construction works.

Extra precaution should be exercised to prevent debris from filling up and damaging the sliding tracks. Dirt or debris must be cleared and the tracks should be properly cleaned prior to the installation of the sliding panels.

Proper labelling is important to ensure that the correct sliding panels are delivered and installed on site as shown in Figure 7.26.

---

**Figure 7.26: Checks to be carried out prior to installation**

![Check that correct panels are delivered](image1)

![Check for correct orientation of panel](image2)

---

Protective tapes on the frames should only be removed prior to the installation of sliding panels.

Sliding panel is installed by slotting the panel into the upper frame track and then inserting the panel onto the bottom track. To do so, the installer has to identify the noggings in the sliding frame. Noggings, as shown in Figure 7.27, are cut-outs in the frame track to allow for the insertion of the panel.

---

**Figure 7.27: Noggings in frame for insertion of sliding panel**

![Noggings](image3)
Installer must check the designer’s plan to determine the installation sequence of the sliding panels. Figure 7.28 shows an example of the installation sequence for a 4-panel sliding window design.

**Figure 7.28: Determine the sequence of panel installation**

Upon completion of the installation of the window panel, installers should check that the sliding window configuration is according to specifications. Safety screws or safety devices are then installed to prevent dislodgment of the panels. The choice of safety device depends on the design of the window.

Sliding window tracks should be cleared of debris/dust prior to handover.

**Figure 7.29: Sequence of installation of sliding window**

47
e) Ensure the panel configuration is as specified by the Designer

f) Fasten the safety screws at nogging areas

Figure 7.30: Method of preventing window panel from being removed/ dislodged

a) Safety screw

b) Safety device

7.4. INSTALLATION OF FIXED GLASS PANEL

Fixed glass windows are commonly used in local buildings. The installation process involves slotting the glass panel into the glass pocket at the bottom frame and securing the panel in place using aluminium beadings.

While it is a common design to install the glass panel from the outside of the building as shown in Figure 7.31, a better design is to allow the installation of the glass panel from inside the building.

In general, fixing of the aluminium beadings should start with the top beading followed by the side beadings. The beadings are knocked in place using millet or the back of the rubberized screwdriver to give sufficient hold on the glass.
Figure 7.31: Fixing of beadings to secure the glass panel

a) Slot the glass panel into the “pocket”
b) Fix the bead to the top of glass panel
c) Secure the top beading
d) Secure the side beading

Spacer blocks are used to press the glass panel against the beadings. The gap between the glass panel & beading could either be sealed by approved sealant or by insertion of gasket in accordance to the Designer’s specifications.

Figure 7.32: Installing the gasket

a) Insertion of spacer blocks
b) Insertion of gasket
7.5. INSTALLATION OF ACCESSORIES

Window installation is completed with the fixing of accessories, including handles, locking devices, etc. Alignment of the accessories should be checked during and after installation. Precaution should be taken to avoid damage to glass panel and window frame in the course of fixing the accessories.

The accessories should be protected until all construction activities are completed.

![Installation of handles](image)

Figure 7.33: Installation of handles

7.6. WATERTIGHTNESS TEST

Water seepage through windows is one of the major problems in Singapore.

Laboratory tests are not able to detect water seepage problems caused by poor workmanship during installation of the window system. Field watertightness test should, hence, be carried out to verify the watertightness performance of the installed windows.

The following parameters are used in CONQUAS 21 field watertightness test:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water intensity</td>
<td>300mm/hr</td>
</tr>
<tr>
<td></td>
<td>1 litre/min/m of joint</td>
</tr>
<tr>
<td>Wind Pressure</td>
<td>240 Pa</td>
</tr>
<tr>
<td>Nozzle inclination</td>
<td>90° to wall</td>
</tr>
<tr>
<td>Distance of nozzle from wall</td>
<td>200mm</td>
</tr>
<tr>
<td>Sample</td>
<td>1 sample = 2m length of joint</td>
</tr>
<tr>
<td>Spray duration</td>
<td>10mins</td>
</tr>
</tbody>
</table>

No sign of seepage should be detected throughout the test.
**Figure 7.34: Conduct field watertightness test**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Portable pump with hoses</td>
</tr>
<tr>
<td>b) Lightweight nozzles (viewed from outside the building)</td>
<td>c) Mounted nozzle heads (viewed from inside the building)</td>
</tr>
</tbody>
</table>

**Figure 7.35: Detection of water seepage**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Seepage through gasket</td>
<td>b) Seepage through joint in frame</td>
</tr>
</tbody>
</table>